Recommendation 22-1R1

FREQUENCY ASSIGNMENT GUIDELINES FOR COMMUNICATIONS IN THE MARS REGION

The SFCG,

CONSIDERING

a) That a regional communication network can be expected in the foreseeable future at Mars as missions to Mars increase in number and variety;

b) That frequencies for direct communication between a spacecraft at Mars and an Earth station are provided in the existing allocations to SRS;

c) That separate frequencies are needed in the Mars region for compatible local communications between a surface vehicle and an orbiter, between surface vehicles, and between orbiters;

d) That major criteria for allocating frequencies include RF compatibility, technology availability and performance, operation scenarios, cost to the missions, and ability to conduct testing and emergency support from the Earth;

e) That, without sufficient frequency separation, a Mars vehicle receiving signals from the Earth can be easily interfered by a signal transmitted by itself or by a local Mars vehicle, and a Mars vehicle transmitting to the Earth can easily interfere with a local receiver;

f) That lower frequency provides better SNR performance for a communication link between two vehicles using low gain broad beam antennas, such as between a rover and a low orbiter;

g) That higher frequency provides better performance between two vehicles employing high gain antennas, such as between a large lander and an orbiter with accurately pointed antennas;

h) That testing Mars local link radios with signals transmitted from an Earth station is allowed only if it does not interfere with Earth-based radio systems operating in accordance with provisions of Radio Regulations; and that techniques such as self test on board are available to minimize the need for testing with Earth-based signals;

i) That the SFCG has resolved to provide assistance to member agencies in coordinating frequency assignment for deep space missions, including missions to Mars (see RES A 21-1);

j) That Mars missions need interoperable relay links to maintain communication with the Earth; and that such links in the UHF band have been defined in the CCSDS Proximity 1 standard;

k) That passive observations in space need to be protected to the extent provided in the Radio Regulations, particularly the quiet zone in the shielded area of the Moon.

RECOGNISING

a) That Mars local links must not interfere with the direct communication links between space and the Earth using frequencies provided in the ITU Radio Regulation;

b) That multiple frequency bands are needed for missions to meet various communications requirements and satisfy cost, mass and performance objectives.

RECOMMENDS

1. That agencies select frequencies from Table 1 for communications in the Mars region according to the specific applicability and precautions recommended in Table 2,

2. That testing Mars local links in flight with signals transmitted from an Earth station be minimized and strictly non-interfering to the Earth-based radio systems operating under the provisions of Radio Regulation;

3. That assignment of Mars local link frequencies be coordinated within the SFCG in accordance with RES A 21-1.

Table 1: Summary of Frequency Bands for Communications in the Mars Region

Space-to-Earth	2290-2300 MHz
	8400-8450 MHz
	31.8-32.3 GHz
Earth-to-space	2110-2120 MHz
	7145-7190 MHz
	34.2-34.7 GHz
Orbit-to-surface:	435-450 MHz**
	2025-2110 MHz
	7190-7235 MHz
	14.5-15.35 GHz
Surface-to-orbit:	390-405 MHz**
	2200-2300 MHz
	8400-8500 MHz*
	16.6-17.1 GHz
Surface-to-surface:	435-450 MHz
	390-405 MHz
	2025-2120 MHz
	2200-2300 MHz
Orbit-to-orbit:	435-450 MHz
	390-405 MHz
	2025-2120 MHz
	2200-2300 MHz
	7190-7235 MHz
	8450-8500 MHz
Approach Navigation & Atmosphere Radio Science	8400-8450 MHz

Multiple frequency bands are provided in Table 1 for each communication link. Table 2 presents specific recommendations on the use of these bands, including the merits and precautions that should be considered before choosing a band.

Figure 1 presents a graphic illustration of the vehicles and communication links, and a conceptual future scenario with frequency bands chosen from Table 1.

Note* - Using this band for the surface-to-orbit link is permitted in the near future when users are few. A user must coordinate with missions using the band for the Space-to-Earth link and operate on non-interfering basis. A user mission to be launched after January 1, 2015 must seek a waiver from the SFCG.

Note** - Operation in the reverse direction is permitted in the near term when users are few. A user must coordinate with missions using the band in the proper direction and operate on non-interfering basis. A user mission to be launched after January 1, 2010 must seek a waiver from the SFCG.

A Conceptual Scenario Circa 2010

(Numbers indicated represent frequency bands, in GHz, selected from Table 1)

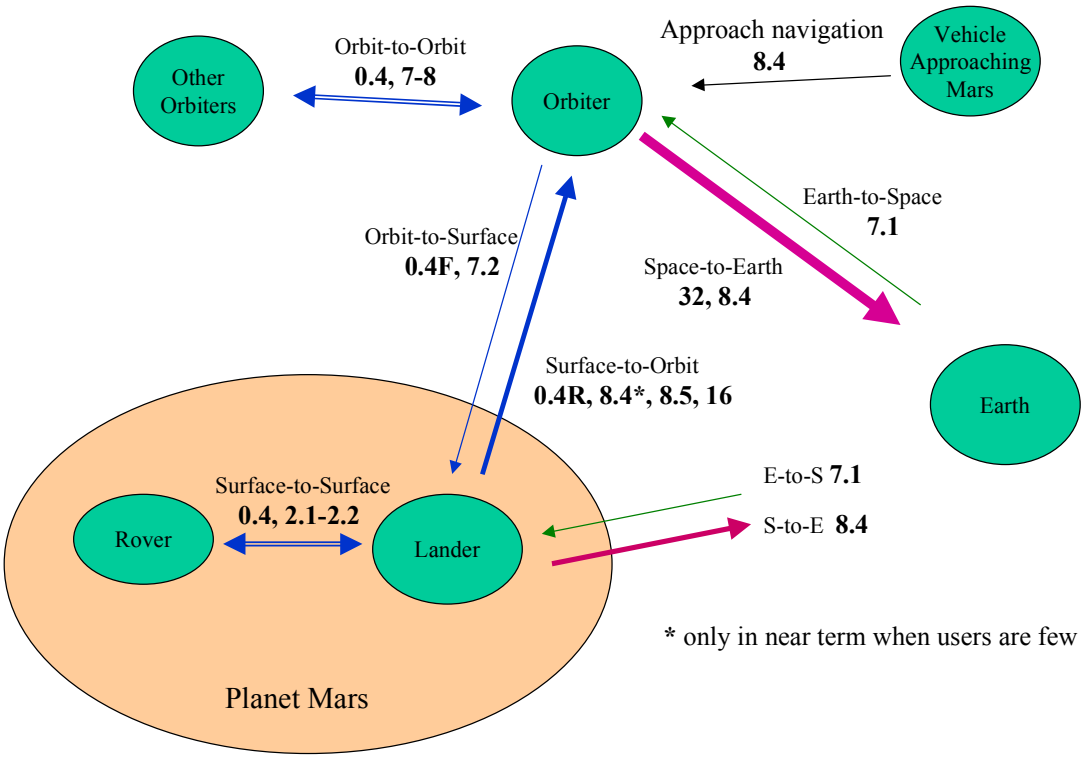

Figure 1

Note: In Figure 1, the numbers in GHz represents a subset of frequency bands from Table 1, as follows:

"0.4"	= 390-405; 435-450 MHz
"0.4F"	= 435-450 MHz
"0.4R"	= 390-405 MHz
"2.1-2.2"	= 2025-2120; 2200-2300 MHz
"7.1"	= 7145-7190 MHz
"7.2"	= 7190-7235 MHz
"7-8"	= 7190-7235; 8450-8500 MHz
"8.4"	= 8400-8450 MHz
"8.5"	= 8450-8500 MHz
"16"	=16.6-17.1 GHz
"32"	= 31.8-32.3 GHz